HABITAT MONITORING AND MANAGEMENT

Habitat Description

Bighorn sheep are able to exploit a variety of habitats throughout the West. While most bighorn populations in Montana occur in the western portion of the state, some of the most productive populations are associated with the Missouri River Breaks in north-central Montana. In developing Montana's Deer Management Program, habitats across the state were defined by five distinct ecological regions (Wildlife Division, FWP, 2001). Environmental characteristics (vegetation, topography, elevation, etc.) help determine how deer and, in this case, bighorn sheep, respond demographically. These five ecological regions were slightly revised based on bighorn sheep habitat characteristics and are used here to describe the various habitats utilized by bighorn sheep in Montana (Figure 11). A description of each ecological region follows:

Northwest Montane:

Description: Hunting Districts 100, 101, 102, 121, 122, 123, 124, 203, 283, and Wildhorse Island. This ecological region encompasses 18,378 square miles including all of FWP Region 1 and the northern tier of hunting districts in Region 2.

Topography varies from rugged, mountainous terrain along the Continental Divide, including the Flathead, Swan, and Mission Ranges, to more gentle, smaller ranges such as the Salish Mountains and Nine Mile Divide. Elevations as low as 2,000 feet occur in the northwestern portion of the unit near Troy to over 9,000 feet on the highest peaks

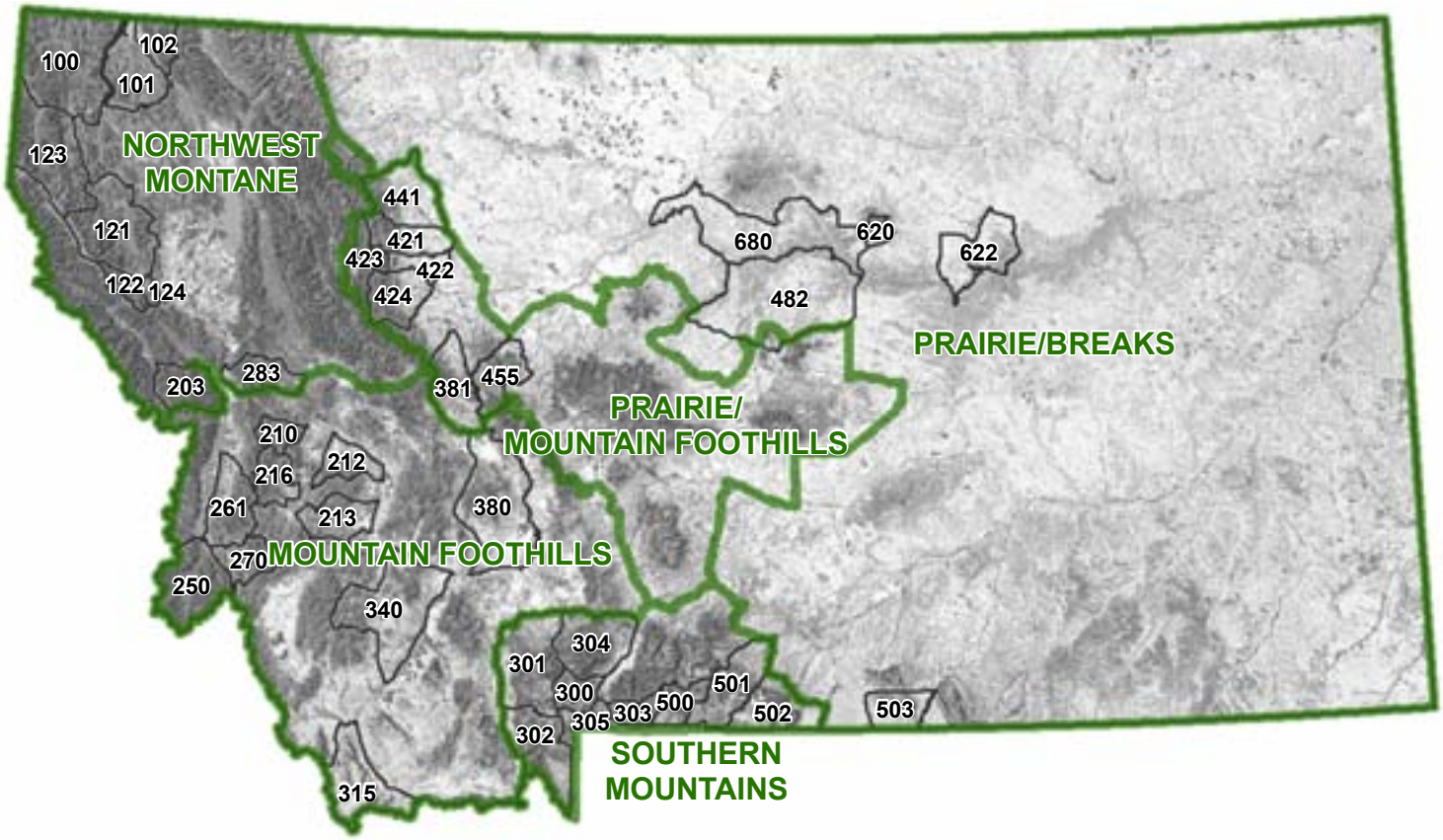

Figure 11. Ecological regions and bighorn sheep hunting districts in each region.

of the Mission Mountains. Climate is strongly influenced by the maritime effect of moisture-laden air from the Pacific Ocean. Precipitation generally decreases from west to east with average annual precipitation at most valley locations varying between 20 and 32 inches, with more than half falling as snow during winter. Vegetation is characterized by the greatest continuous cover of coniferous forest of any ecological region in the state. Forest cover extends across most valley bottoms with natural openings limited in size and distribution. Overstory species that occur at lower elevations include ponderosa pine, Douglas fir, and western larch. At higher elevations, dominant species include lodgepole pine, Engelmann spruce, and subalpine fir. Relic stands of western red cedar, grand fir, western white pine, and western hemlock are confined to moist microsites. Plant communities in the understory are represented by a diversity of species such as pine grass, beargrass, Oregon grape, spirea, huckleberry, twinflower, queencup beadlily, and arnica. Timber-related industries, tourism, mining, and agriculture are important land uses. Public land accounts for nearly 75% of this population management unit, although timber corporations privately own large parcels. Noncorporate private land consists of small parcels confined to major river valleys.

Dense forests preclude efficient aerial surveys for bighorn sheep in this ecological region.

Mountain Foothills:

Description: Hunting Districts 210, 212, 213, 216, 250, 315, 340, 380, 381, and Bearmouth. This ecological region encompasses 21,733 square miles of southwestern Montana including high-to-moderate elevation mountain ranges (e.g., Elkhorn Mountains, Bridger Range, west slope of Big Belts, Tendoy Mountains, Bitterroot Range, Sapphire Mountains, and Garnet Mountains) generally isolated from other ranges by large valleys.

Topography varies from gently undulating foothills to rugged mountainous terrain with elevations ranging from 4,000 to 11,000 feet. Topography and elevation cause variation in local climate and weather conditions across this ecological region. Most mountain ranges are oriented along a north-south trending axis. More persistent snow cover and a more restricted distribution of winter range generally characterize westerly aspects. Easterly aspects occur in drier rain shadow zones and provide more extensive areas of winter habitat. Vegetation in the foothills includes a variety of shrub species (big sage, bitterbrush, mountain mahogany, and juniper) interspersed among bunchgrass communities dominated by bluebunch wheatgrass and Idaho fescue.

Riparian areas support cottonwood, aspen, willow, and hawthorn. Conifer forests of Douglas fir, ponderosa pine, lodgepole pine, subalpine fir, and whitebark pine become prevalent with increasing elevation. Subalpine and alpine vegetation is restricted to elevations above about 8,500 feet. Cattle grazing and both dryland and irrigated crops are primary uses of private land. Timber management, livestock grazing, and recreation are major uses of public land.

Prairie/Mountain Foothills:

Description: Hunting Districts 421, 422, 423, 424, 441, and 455. This ecological region encompasses 14,552 square miles of central Montana and includes the Rocky Mountain Front, east slope of the Big Belt Mountains, and the Little Belt, Judith, Castle, Big Snowy, Little Snowy, Moccasin, and Crazy Mountains.

This population management unit represents a transition zone having characteristics of both the mountain/foothills and the prairie/breaks units. Topography varies from low rolling hills to steep, rugged mountain canyons. Elevations range from less than 4,000 feet to over 9,000 feet near the Continental Divide. Precipitation is highly variable, ranging from 10 to 12 inches at lower, more arid sites to more than 40 inches in the mountains. Vegetation varies from shrub grasslands, through montane forest with intermountain grasslands, to alpine ridgetops. Cottonwood, willow, and aspen dominate riparian areas. Cattle grazing is the primary land use. Cropland is primarily irrigated and dryland alfalfa.

Some of these bighorn populations have complex, long-range migrations between seasonal habitats. Harvest strategies, especially on the ewe segment, should be designed in such a way as to ensure maintenance of these migratory traditions.

Southern Mountains:

Description: Hunting Districts 300, 301, 302, 303, 304, 305, 500, 501, 502, and Mill Creek. This ecological region encompasses 5,989 square miles in the Absaroka, Beartooth, and a portion of the Gallatin and Madison Ranges in south-central Montana.

Topography varies from rolling hills to sheer mountain canyons thousands of feet deep. Elevations range from 4,500 feet to nearly 13,000 feet. Precipitation varies from less than six inches annual rainfall in the Cottonwood Triangle to more than 40 inches per year in the mountain environments. Vegetation varies from shrub desert, through montane forest with intermountain grasslands, to alpine plateaus. Cottonwood, willow, and aspen dominate riparian areas. Cattle grazing is the primary land use. Cropland is primarily irrigated and dryland alfalfa, though the Clark's Fork Valley supports corn and sugar beet production.

Some of these bighorn populations have complex, long-range migrations between seasonal habitats. Harvest strategies should be designed in such a way as to ensure maintenance of these migratory traditions.

Prairie/Breaks:

Description: Hunting Districts 482, 503, 620, 622, and 680. The Prairie/Breaks ecological region encompasses 86,277 square miles in the eastern two-thirds of Montana and includes some hunting districts in FWP Regions 4 and 5 and all hunting districts and populations in Regions 6 and 7 (Figure 12). Landforms consist of flat to rolling benchlands, ponderosa pine savannahs, rugged badlands or breaks adjacent to major rivers, and riparian areas. The semiarid climate is characterized by hot, dry summers and cold, dry winters, but large annual fluctuations in temperature and precipitation during all seasons are common. Dryland small grain farming and livestock grazing are the primary commercial land uses, except in the major river valleys where irrigated acreage produces alfalfa, sugar beets, corn, and small grains.

Native habitats consist primarily of grasslands, sagebrush and grasslands, deciduous shrub grasslands, hardwood draws, breaks, and river bottoms. Grasslands in good condition are dominated by western wheatgrass, thickspike wheatgrass, slender wheatgrass, bluebunch wheatgrass, green needlegrass, little bluestem, and various forbs. Shrubs found in sagebrush and grasslands consist of big sagebrush, silver sagebrush, rubber rabbitbrush, skunkbrush, sumac, and black greasewood, while deciduous shrub grasslands include buffaloberry, chokecherry, snowberry, wild rose, and hawthorn. Ponderosa pine is the major tree species in savannahs and, along with Rocky Mountain and common juniper, predominates in breaks habitats. Hardwood draws feature green ash, boxelder, American plum, and American elm, while river plains cottonwood and willows dominate river bottoms.

Seventy to 90% of the land in this management unit is in private ownership, with blocks of public land scattered throughout. Public lands are primarily under federal management by the Bureau of Land Management (BLM), the U.S. Forest Service (USFS), or the U.S. Fish and Wildlife

Service (USFWS). State lands accessible to the public include areas managed by FWP or the Department of Natural Resources and Conservation (DNRC). Land open and accessible to the public for hunting ranges from a low of l0% in the southeast to 95% in portions of the northeast.

Most populations in this ecological region are associated with the Missouri River Breaks, which provides highly productive habitats with abundant escape terrain.

Habitat Use

Bighorn sheep in Montana are adapted to a wide variety of habitats as characterized by the ecological descriptions above. To understand and address habitat issues, it is important to have a working knowledge of what habitat elements are important to bighorn sheep. Although habitats may vary across the state in relation to vegetation types, ruggedness, elevation, etc, there are attributes of habitat that are consistent across ecological regions. These attributes, to a large degree, influence the ability of a population to achieve it's potential demographically. Three elements are essential to quality bighorn habitat, and it is these elements that are degraded by plant succession or human-induced activities.

1) Escape cover or terrain is a common element in all seasonal habitats. Bighorn sheep, especially ewes, are generally found within 100 to 300 m of escape terrain (Oldemeyer 1971; Erickson 1972; Smith et al. 1991; Douglas and Leslie 1999). Escape terrain is comprised of slopes 60% or greater with occasional rock outcroppings. Escape terrain also has abundant open foraging areas adjacent to it. Areas with dense timber tend to receive little use except in areas in the Northwest Montane ecological region where bighorns have adapted to timbered habitats.
2) High visibility in all bighorn habitats is recognized by most biologists as being highly important in the detection and avoidance of predators as well as access to forage and foraging efficiency (Geist 1971, Risenhoover and Bailey 1985, Wakelyn 1987).
3) Winter range areas tend to be low-elevation, south-facing slopes with escape cover in proximity to foraging areas. Winter range is defined as all escape terrain, which receives less than 25 cm (approximately 10 inches) of snowpack. Research in Utah indicated that bighorn sheep abandoned ranges when snowpack exceeded 25 cm (Smith et al. 1991). Bighorn sheep in the West Rosebud drainage and the Southern Mountains ecological region winter on high elevation windswept slopes and migrate to lower elevations prior to lambing.

To determine if habitat characteristics in these ecological regions influence lamb production and recruitment and ram to ewe ratios, a simple comparative analysis of each region was conducted. Lamb recruitment rates and ram: ewe ratios for each population in the five regions were averaged for the past five years of survey data available for each population (Table 5). Populations having gone through recent major declines due to die-offs were excluded from this analysis.

From this analysis, it appears that lamb: ewe ratios are generally higher in the more productive ecological regions, with the Prairie/Breaks having the highest ratio. Lamb production was correlated more with environmental conditions than ewe harvest rates. Ram: ewe ratios don't vary much among regions, and ratios are more a function of conservative harvest on the ram segment.

Food Habits

Bighorn sheep forage opportunistically and utilize vegetation types that occur within their seasonal distribution. With few exceptions, bighorns utilize forbs heavily in the spring when they are readily available (Oldemeyer 1971; Erickson 1972; Frisina 1974). As forbs desiccate during summer, diets switch to more grass and grass-like plants (Frisina 1974, Stewart 1975).

Table 5. Comparison of lamb recruitment rates and ram ratios by ecological region, excluding populations having recently gone through a die-off.

Ecological Region	Lambs: 100 Ewes	Rams: 100 Ewes
Northwest Montane	37	65
Mountain Foothills	44	55
Prairie/Mountain Foothills	44	64
Southern Mountains	35	41
Prairie Breaks	49	63

Some bighorn populations make substantial use of browse species at certain times of the year. Stewart (1975) found that in the West Rosebud herd, which winters on the high-elevation Beartooth Plateau and migrates to lower elevations in late winter, diets were comprised of as much as 40% big sagebrush (*Artemesia tridentata*). Schallenberger (1966) observed winter diets with 43% browse species in the Sun River bighorn sheep. During periods of heavy snowpack, bighorn sheep in northwestern Montana utilize Douglas fir needles as a winter food source.

Major Habitat Issues

Habitat issues identified for Montana bighorn sheep populations are described in the individual management plans for hunting districts and populations in Chapter 2. Most of the issues identified are similar to those occurring throughout other western states and Canadian provinces where bighorn sheep occur. A review of those individual management plans found that the primary issues affecting bighorn sheep habitat were deterioration, loss, and fragmentation. Major habitat issues include:

1) Residential and resort developments have had a major impact on some seasonal ranges resulting in direct loss of habitat, fragmentation of habitats, and displacement of bighorns to less productive habitats.
2) Highway development and maintenance has fragmented some habitats making connection between subpopulations more difficult. Maintenance of highways, particularly during winter when salting occurs, has attracted bighorns to roadsides resulting in significant vehicle collision losses in some populations. The type of fencing used along highways can impede movements. Illegal use of ATVs on public lands has in some cases been detrimental to bighorn habitats.
3) Industrial developments such as dam development, hard rock mining, oil and gas development and exploration, and electrical transmission lines have resulted in direct loss of habitat, deterioration of habitat, reduced bighorn populations, displacement to less productive habitats, and fragmentation of existing habitats.
4) Livestock grazing on private and public lands has in some cases been detrimental to bighorn sheep habitats. The type of fencing used on some allotments can impede movements. Wild horses have degraded wildlife habitats in a few areas in Montana. Conversion of grazing allotments on public lands from cattle to domestic sheep in areas adjacent to known bighorn sheep distribution has, at times, been an issue. This situation is a habitat as well as a health issue for bighorn sheep.
5) Forest succession or woody plant encroachment into former grasslands or shrub grasslands, caused in part by historical overgrazing by livestock and fire suppression efforts, has resulted in loss of habitat including linkages between habitats and subpopulations.
6) Noxious weeds, especially in the western part of Montana, have resulted in the loss of productivity of seasonal ranges. The use of domestic animals for weed control is an emerging issue that has potential for displacement of bighorn sheep and also is a serious health issue to bighorn sheep should contact occur.
7) Competition for forage with other wild ungulate species has not been a serious issue in most bighorn populations in Montana to date but has the potential to be so in certain habitats.
8) Human disturbance on critical winter and lambing ranges.

A ranking of the above issues and a few other issues listed as management challenges in Chapter 2 by herd unit/population indicates some common challenges for bighorn sheep and sheep managers across the state (Table 6). Of particular concern is that in 57% of the populations, domestic sheep and the potential for contact with wild sheep either on allotments, private land, while being used for noxious weed control or on adjacent hobby farms was listed by biologists as a management challenge. Secondly, noxious weeds and impact on season range vegetation was listed as a major challenge in 48% of the populations, especially in western Montana. Conifer encroachment resulting in habitat loss and decreased visibility was an important management concern in 57% of populations, again mostly in western Montana. Human development with residential and industrial development combined was an issue in 46% of the populations. Direct loss of bighorn sheep through road kill was an issue in 27% of the populations. Impacts of predation were not a major management issue at this time for most populations.

Habitat deterioration, loss, and fragmentation are the greatest threats to the

maintenance and viability of wildlife habitats and populations. Most impacts on wildlife habitats are human induced. The ability to influence human activities that negatively affect wildlife habitats is one of the major challenges facing wildlife and land managers today. FWP doesn't directly manage a significant amount of bighorn sheep habitat. Instead, FWP biologists attempt to work with other state and federal land management agencies by offering input into their managing activities. Additionally, where bighorn sheep habitat occurs on private land, FWP works with the landowners in a variety of ways to ensure wildlife use of private lands is compatible with landowner objectives. FWP recently created a Land Use Planning Specialist position and as a result information is now being provided to local governments (county planning boards) on the location of important fish and wildlife habitats, economic values of resources managed by FWP, and contact information to obtain additional information for those resources from FWP specialists.

Monitoring and Management of Habitats

As part of the effort to develop this Conservation Strategy for bighorn sheep, a statewide Geographic Information System (GIS) analysis has been implemented with one of the objectives being to conduct risk analysis to bighorn sheep habitats due to human activities. This analysis is being conducted by ecological region (see above), as habitats vary across the state and this is a logical partition of Montana in relation to bighorn sheep habitats and human demographics. The intent of this analysis is to look at habitats on a statewide basis that may be threatened and to provide that information to the appropriate region. The analysis is expected to be ongoing as new information becomes available. Outcomes of this analysis will include the identification of which bighorn sheep habitats are at greatest risk due to human activities (primarily development) and help prioritize which habitats FWP and other organizations may wish to target for preservation.

Some of the major impacts to bighorn habitat and movement patterns are human development of critical seasonal ranges. This includes not only subdivisions but also development of resorts. Development and expansion of the Big Sky Resort in the Gallatin Canyon south of Bozeman has resulted in increased vehicle traffic and bighorn mortality due to collisions with vehicles. Areas of bighorn sheep habitat in western Montana that were recently unoccupied and suitable for translocation may no longer be suitable due to subdivision development.

Industrial developments such as dams, hard rock mining, and energy development have had and will likely continue to have negative impacts on bighorn sheep habitats. The dams forming Lake Kookanusa in northwest Montana and Fort Peck Reservoir in eastern Montana flooded historical bighorn range. Mitigation measures designed to replace that loss in northwest Montana through burning and logging were ineffective (Stansberry 1998). Hard rock mines in the Little Rockies and the Stillwater River have had adverse and long-term effects on bighorns in those areas.

The biggest challenge for a variety of wildlife species and associated habitats in the near future will be energy exploration, development, and transmission of those resources. An area that was extensively explored for oil and gas development in the 1980s but currently has been withdrawn from further consideration is the Rocky Mountain Front where the Sun River herds are located. Studies done on bighorn sheep during that exploratory period showed displacement during seismic activity along with decreased home range sizes (Hook 1986). Powerline and pipeline transmission systems are currently being proposed with more being planned. The impact of these systems on bighorn habitat is not known at this time as locations are still being determined. Close monitoring of all such impacts will track potential effects to wildlife habitats, and appropriate recommendations will be made including measures to mitigate impacts if necessary.

Most bighorn sheep habitat in Montana occurs on public land, primarily USFS and BLM lands. It is incumbent on FWP biologists to work closely with wildlife biologists and resource specialists from these agencies and other land managing agencies in their management of bighorn sheep habitats. It should be recognized that the mandates governing the management of USFS and BLM lands are quite different than those of a state wildlife agency; however, the goal of managing natural resources in a sustainable manner is a common goal among many agencies.

There are three major issues concerning the management of bighorn sheep habitats on public lands in Montana. These issues are inter-related and influence each other. The issues are: 1) livestock management on seasonal bighorn sheep habitat, 2) forest succession or the encroachment of conifers into former grassland or shrub grassland habitats, and 3) the influence of noxious weeds on the vegetation

Table 6. Population status of bighorn sheep by hunting district and various threats to these populations.

Herd Unit Name	H.D.	Threats to Population											
		Preda-tion	Dom. Sheep	Weed Control/ Dom.	Hobby Sheep	3/ Human Develop	Road Kills	Conifer Encroach-ment	Small Range Size	Noxious Weeds	ATV's	Wildlife Competition	Social Limits
Kootenai Falls	100				X	X	X	X					
Ural-Tweed	101							X					
Galton Range	102		X					X		X			
North Clark Fork	121				X		X	X					
Clark Fork Cut-Off	122				X		X	X		X			
Cabinet Mountains	123				X		X	X		X			X
Paradise	124				X		X	X		X			
Wildhorse Island								X		X			
Grave Creek Range	203				X	X	X	X		X	X		
John Long Range	210		X			X	X	X		X			
Garrison	212		X	X		X		X		X			
Lost Creek	213		X	X	X	X		X		X			
West Rock Creek-Quigg Peak	216			X	X			X		X			
Watchtower	1/ 250							X		X			
Paint. Rocks			X							X			
Skalkaho	261		X		X	X	X	X		X	X		
E. Bitteroot	270		X		X	X	X	X		X			
Lower Blackfoot	283			X	X	X	X	X		X			X
2/ Gallatin-Yellow-stone	300					X							
Spanish Peaks	301		X			X	X	X			X		
Hilgard	302		X	X			X					X	
South Absaroka	303												
Hyalite	304												
South Yellowstone	305												
Tendoy Mountains	315		X			X							
Highland Moun-tains	340				X	X	X	X		X			

Table 6. continued.

Herd Unit Name	H.D.	Threats to Population											
		Predation	Dom. Sheep	Weed Control/ Dom.	Hobby Sheep	Human Develop	Road Kills	Conifer Encroachment	Small Range Size	Noxious Weeds	ATV's	Wildlife Competition	Social Limits
Radersburg	380		X			X				X			
Sleeping Giant	381		X			X	X			X			
Mill Creek													
Greenhorns			X										
Deep Creek	421												
Castle Reef	422												
Gibson Lake North	423												
Ford Creek	424												
North Fork Birch Creek-Teton	441									X			
Fergus	482												
Beartooth WMA-GMWA	455		X		X					X			
Stillwater River	500								X		X		
Monument Peak													
Beartooth Mountains	501								X		X		
Hellroaring	502												
Pryor Mountains	503		X	X								X	
Little Rockies	620												
Middle Missouri Breaks	622												
Chouteau-Blaine-Phillips	680												
Blue Hills			X	X									

1/ The Watchtower and Painted Rocks subunits have separate winter areas but do have interchange and are considered one population.
2/ Population objectives for the Upper Yellowstone Complex is for a total of 215 bighorn sheep and includes sheep in Hunting Districts 300, 303, 304 and 305.
3/ Human developments include residential and industrial development.

resource. It is generally recognized, in relation to forest succession, that historical overgrazing by livestock along with fire suppression has promoted encroachment on grassland-type habitats (Arno and Gruell 1986). Additionally, improper livestock management can promote the establishment and spread of noxious weeds.

Livestock And Other Wild Ungulate Grazing Issues

Cattle grazing has had variable effects on bighorn sheep habitats. McCollough et al. (1980) found that while cattle and bighorn diets were somewhat similar, bighorn sheep used steep slopes avoided by cattle; thus cattle had minimal impact on winter and spring areas deemed to be critical to bighorn sheep. In another study, bighorn sheep core habitat areas and distance to escape terrain decreased in response to proximity to cattle (Bissonette and Steinkamp 1996). These researchers observed that bighorn sheep moved away from cattle when approached. Cattle use resulted in fragmented habitat, as less area was available to bighorn sheep when cattle were present. Taylor (2001) reported ewes were displaced by the presence of cattle. When cattle stocking rates were excessive, bighorn sheep avoided otherwise suitable habitats due to excessive forage removal. He concluded the activities that attract cattle in bighorn sheep habitats (water development, salt placement, fences corrals) should be avoided. Also, cattle use of forage within 300m of known bighorn escape cover should be closely monitored for excessive use as these areas are important bighorn foraging areas.

The type of grazing system can affect bighorn sheep use of an area. Under season-long grazing of bighorn sheep winter range by cattle, bighorns preferred areas not already grazed by livestock (Bodie and Hickey 1980). Four years after implementing a rest-rotation grazing system, bighorn use shifted from an area closed to livestock grazing to the livestock-use pastures. It appeared that bighorn sheep preferred late-use pastures to early-use or rested pastures. Apparently, this was because late-use pastures were early-use pastures the previous year, and the combination of two years of grazing removed residual vegetation, providing for fall green-up preferred by bighorns. Similarly, Weigand (1994) noted use of rest pastures by bighorn sheep and general avoidance of cattle in a rest-rotation grazing system in the Highland Mountains in Montana. Weigand (1994) also looked at potential forage competition between domestic sheep, other wild ungulates, and bighorn sheep. Domestic sheep and wild sheep had similar food habits but the overriding issue was disease transmission from the domestic animals and not forage competition. Competition for forage with elk, deer, or antelope in this study was low due to the lack of spatial overlap. Weigand (1994) as well as other researchers (Constan 1970; Schallenberger 1966) concluded elk and bighorn sheep could compete for forage on winter range, as both species prefer graminoids at that time of year.

Another wild ungulate in Montana potentially competing for habitat with bighorn sheep is the mountain goat (*Oreamnos americanus*). In other parts of the West and in portions of Montana, mountain goats have been introduced into areas of native bighorn sheep habitat; this has resulted in concerns of competition between the two species for forage and space (Adams et al. 1982; Reed 1986). An area of concern is the Absaroka Mountains of south-central Montana where mountain goats were introduced beginning in 1956. This was an area inhabited by native bighorn sheep. Varley (1996) addressed the potential for competition between the two species in studying the ecology of this expanding population of mountain goats. In this case, there were differences in habitat selection and feeding behavior, which enabled the two species to avoid direct competition. At the time of his study, there was little overlap of the two species on winter range where he believed direct competition for forage could occur.

Cooperrider (1969) looked at the potential for competition for food between mule deer and bighorn sheep on Rock Creek bighorn sheep winter ranges in western Montana. Competition for grass was minimal because of different habitat preferences and high use of sagebrush by mule deer compared to bighorns.

Because of potential interactions between bighorn sheep and other grazers, both domestic and wild, it is essential for biologists and resource specialists from other agencies to assess range use and vegetation condition on important bighorn seasonal ranges. This assessment needs to occur for existing bighorn sheep populations as well as potential new transplant sites (see the Habitat Evaluation Procedure in the Translocation Program section).

Forest Succession and Fire

Arno and Gruell (1986), in studying conifer encroachment in mountain grasslands, concluded that since 1890, when major fires across the West decreased as a result of excessive livestock grazing, fire suppression efforts, and cessation of ignitions by Native Americans, Douglas fir (*Psuedotsuga menziesii*)

has become established in former grassland vegetation types. The importance to bighorn sheep of escape terrain and open habitats with good visibility and acceptable forage has been well documented (Geist 1971; Risenhoover and Bailey 1985; Wakelyn 1987). Further, Wakelyn (1987) found that ranges supporting greater numbers of bighorn sheep in Colorado had more high-visibility habitat, greater area dominated by grassland and rock cover, more habitat near open escape terrain, and greater topographic relief than ranges supporting fewer or no sheep. She also concluded that because of the lack of fire, forest succession has been a major cause of habitat loss for bighorn sheep. Risenhoover et al. (1988) suggested that bighorn sheep populations have continued to decline due to loss of habitat and disease. They further stated that maintenance of migration corridors providing sufficient visibility and escape terrain is critical to maintenance and mobile sheep populations. Additionally, Risenhoover et al. (1988) believed that ineffective management in relation to forest succession has resulted in small, isolated, and sedentary sheep herds. Enk et al. (2001), in studying the slow recovery of a bighorn sheep population in west-central Montana following a die-off, concluded that the lack of migratory behavior affected ewe productivity. Because this herd remained at low-elevation range throughout the year where the nutritional quality of summer forage was low, immunocompetence, susceptibility to disease, and herd productivity was negatively influenced. Risenhoover et al. (1988) recommended identifying seasonal ranges, migration corridors, and factors limiting bighorn range expansion. They further recommended the use of prescribed fire to improve visibility on these habitats, which encourages migratory movements and thus the use of adjacent habitats.

Peek et al. (1985) reviewed the affect of fire on seven bighorn sheep populations in a variety of habitats. They concluded that prescribed fire will not necessarily increase bighorn sheep populations and may have a negative effect. In areas of high fire frequency where plant responses are short-lived the bighorn sheep response may also be short-lived or nonexistent. There was evidence that prescribed fire used in conjunction with controlled livestock grazing plans may benefit bighorn sheep.

Other researchers also have reached varying conclusions on the use of prescribed fire and its affect on bighorn sheep ecology and sheep habitats. Hobbs and Spowart (1984) found that prescribed burning improved nutrition of winter diets but not spring diets and that treatment effects were short-lived (two years). Bentz and Woodward (1988) observed decreased use of four burn sites as distance from escape cover increased. At distances greater than 300m from escape cover, little use occurred. McWhirter et al. (1992) found preference for burned areas occurred in the spring but not in the winter, and that crude protein in simulated diets was greater in the spring compared to controls. Herbaceous production was greater in two of the four burn sites, bighorn sheep spent more time feeding in burn sites, and preferred areas for foraging were those opened up through removal of shrubs and trees.

In any effort to manipulate habitats with the objective of benefiting wildlife, a well-thought out plan must be developed (Peek et al. 1984). Additionally, an adequate monitoring program needs to be implemented to determine long-term affects on the vegetation and responses, in this case, on bighorn sheep populations.

McBratney et al. (1998) discussed the importance of implementing prescribed fire as well as letting wild fire burn in appropriate well-defined areas. The objective is to return fire to a more historical and landscape level to benefit a variety of wildlife species. FWP needs to work with other resource managing agencies to jointly determine where it is appropriate to let naturally ignited fires burn. Part of that decision will involve attempting to map migration and movement corridors in an effort to maintain openness and connection between wildlife habitats. FWP, as part of this Conservation Strategy, is working on a GIS Habitat Risk Analysis. This effort will be ongoing as new information becomes available, but the initial analysis will include known movement patterns of bighorns, critical seasonal bighorn habitats, and habitats that may be threatened by human development. This effort will help FWP, other agencies, and interested parties in prioritizing efforts to protect bighorn sheep habitats and populations now and in the future.

Noxious Weeds

Across Montana there are a little over eight million acres (9%) infested with noxious weeds; this includes every county in the state (Duncan 2008). The ecological and economic impacts caused by noxious weeds are numerous and include impacts to water quality, reduction in long-term production of land, loss of native vegetation species, increased erosion, and loss of wildlife habitat. Knapweeds in Montana cost an estimated $42 million annually (Hersch and Leitch 1996).

As mentioned earlier, most bighorn sheep habitat in Montana occurs on lands managed by the USFS and the BLM. The Forest Service manages 16.9 million acres in Montana with an estimated 900,000 acres (5%) infested with

noxious weeds (Duncan 2008). The BLM manages about eight million acres in Montana with about 1,116,058 acres (14%) currently infested with noxious weeds (Duncan 2008). Both agencies spend about $1.5 million each on noxious weed management annually in Montana. It is estimated that to effectively manage noxious weeds, each agency needs to spend about $6 million annually (Duncan 2008). These statistics point out that inadequate resources are being applied in an effort to control noxious weeds on public lands.

In recent years, wildfires have increased in the West, both in number and size. The use of prescribed fire to manage vegetation has become an integral part of the USFS and BLM's resource management programs and plans. Additionally, both agencies have and are currently developing plans where it is appropriate to let naturally ignited fires to burn. There are obvious benefits to allowing fires burn where appropriate, e.g., fuel reduction, meeting vegetation objectives, and reduced suppression costs; however, one of the primary issues with fire management programs today is the spread of noxious weeds. Most noxious weeds are forbs, which respond positively to the disturbance caused by fire. Frequently, standard protocol on federal lands to address noxious weed infestations that occur in areas targeted for prescribed burning is preliminary identification of the distribution of the infestation, treatment of the infestation one year before burning and one year after burning, and perhaps additional monitoring thereafter. Depending on weed species present and the extent of the infestation, proliferation of the infestation. FWP supports appropriate burning programs and needs to work with land managing agencies to ensure that noxious weeds are adequately treated by an appropriate method in relation to managed fire where wildlife habitats are concerned.

Another emerging issue related controlling noxious weeds in Montana in relation to bighorn sheep is the use of domestic animals to control infestations through grazing. This may be an appropriate technique but not in the proximity of bighorn sheep because of the concern over transmission of disease from domestic sheep or goats to bighorn sheep. As part of this Conservation Strategy, FWP has developed recommendations of where it may be appropriate to use this weed management technique without threatening the health of bighorn sheep (see the Health Monitoring and Managment section).